AMENDED CLAIMS

**[Received by the International Bureau on 15 December 2005 (15.12.2005):
original claims 1-55 replaced by amended/added claims 1-71; (16 pages)]**

1. A method for heating a medium, said medium comprising hydrocarbonaceous material
    selected from the group consisting of oil shale, tar sand, oil sand, coal, bitumen, and/
    or kerogen, comprising:
    (a) subjecting said medium to an alternating current electrical field generated by a
        radio frequency waveform applied at a predetermined frequency range that heats
        said medium;
    (b) measuring an effective load impedance initially dependent upon the impedance of
        said medium;
    (c) comparing said effective load impedance with an output impedance of a signal
        generating unit that generates said radio frequency waveform; and
    (d) automatically adjusting said effective load impedance to match said output
        impedance of said signal generating unit.

2. The method of claim 1 wherein said output impedance of said signal generating
    unit is a predetermined constant.

3. The method of claim 2 wherein said output impedance of said signal generating
    unit is about 50 ohms.

4. The method of claim 2 wherein said output impedance of said signal generating
    unit is in a range of about 20 to 100 ohms.

5. The method of claim 1 wherein measuring said effective load impedance includes
    measuring a voltage across said medium and measuring a resulting electric field
    developed in said medium.

6. The method of claim 1 wherein measuring said effective load impedance includes
    measuring a current of said radio frequency waveform applied to the medium.

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7. The method of claim 1 wherein measuring said effective load impedance includes measuring a voltage and a current of said radio frequency waveform applied to said medium, and determining a phase angle based on the measured voltage and measured current.

8. The method of claim 1 wherein measuring said effective load impedance includes measuring a forward power level of said radio frequency waveform applied to generate a voltage across and current through said medium and a reverse power level of said radio frequency waveform reflected from an effective load.

9. The method of claim 8, further comprising calculating a voltage standing wave ratio from said forward power level and said reverse power level.

10. The method of claim 9, further comprising repeating the act of automatically adjusting said effective load impedance until said voltage standing wave ratio is about 2:1 or less.

11. The method of claim 9, further comprising repeating the act of automatically adjusting said effective load impedance until said voltage standing wave ratio is about 1:1.

12. The method of claim 1 wherein automatically adjusting said load impedance to said output impedance of said signal generating unit includes adjusting said selected frequency of said applied radio frequency waveform.

13. The method of claim 1 wherein automatically adjusting said effective load impedance to match said output impedance of said signal generating unit includes tuning a tunable impedance matching network connected to an effective load.

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14. The method of claim 1, further comprising periodically measuring at least one temperature of said medium during heating, and using said measured temperature in automatically adjusting said effective load impedance to match said output impedance of said signal generating unit.

15. The method of claim 1 wherein said radio frequency waveform allows for a wavelength to be greater than a geometrical dimension of said medium.

16. The method of claim 1 wherein said selected frequency of said radio frequency waveform is in a range of 1 MHz to 300 MHz.

17. The method of claim 1 wherein said selected frequency of said radio frequency waveform is greater than about 300 KHz.

18. The method of claim 1 wherein said medium is heated with said radio frequency and released under a pressure.

19. The method of claim 1 wherein at least one specific chemical composition residing in said medium is targeted for heating by said radio frequency.

20. The method of claim 1 wherein said medium is exposed to a carrier medium, said carrier medium allowing passage of said radio frequency waveforms to heat said medium.

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21. A method for heating a medium, said medium comprising hydrocarbonaceous material contained in a subterranean environment, comprising:

(a) subjecting said medium to an alternating current electrical field generated by a radio frequency waveform applied at a predetermined frequency range that heats said medium;

(b) measuring an effective load impedance initially dependent upon the impedance of said medium;

(c) comparing said effective load impedance with an output impedance of a signal generating unit that generates said radio frequency waveform; and

(d) automatically adjusting said effective load impedance to match the output impedance of said signal generating unit.

22. A method for heating a medium, said medium comprising hydrocarbonaceous material, comprising:

(a) subjecting said medium to an alternating current electrical field generated by a radio frequency waveform applied at a predetermined frequency range that heats said medium;

(b) measuring an effective load impedance initially dependent upon the impedance of said medium;

(c) comparing said effective load impedance with the output impedance of a signal generating unit that generates said radio frequency waveform;

(d) automatically adjusting said effective load impedance to match the output impedance of said signal generating unit; and

(e) exposing said medium to a subterranean reservoir of a carrier medium, said carrier medium being a fluid which allows radio frequency waves to travel to said medium.

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23. The method of claim 22 wherein said medium is heated while exposed to said
   reservoir of said carrier medium.

24. The method of claim 22 wherein said medium that is generally adjacent to said
   reservoir is heated, said carrier medium in said reservoir being maintained at a
   temperature range below boiling point of said carrier medium.

25. The method of claim 22 wherein a desired compound derived from heating said
   medium forms a recoverable layer within said reservoir, and said recoverable layer
   can be extracted from said reservoir.

26. A method for heating a hydrocarbon-bearing formation, comprising:

   (a) subjecting said hydrocarbon-bearing formation to an alternating current field
       produced by applying a radio frequency waveform at a predetermined variable
       frequency with a signal generating unit, said signal generating unit having a
       generally constant output impedance;

   (b) measuring an actual impedance of said hydrocarbon-bearing formation;

   (c) determining an effective load impedance, said effective load impedance initially
       dependent upon said actual impedance of said hydrocarbon-bearing formation, said
       effective load impedance being determined by at least one of measuring a voltage
       and current of an applied radio frequency waveform and computing a phase angle
       difference, and measuring a forward power level of said radio frequency waveform
       applied to said hydrocarbonaceous matter and a reverse power level of said radio
       frequency waveform reflected from said hydrocarbon-bearing formation with
       circuitry of said signal generating unit;

   (d) comparing said effective load impedance with said output impedance of said signal
       generating unit; and

   (e) automatically matching said effective load impedance to said output impedance of

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said signal generating unit by at least one of adjusting the frequency at which said radio frequency waveform is applied and tuning a tunable impedance matching network such that said effective adjusted load impedance is approximately equal to said output impedance of signal generating unit.

27. A method for heating a hydrocarbon-bearing formation, comprising:

> maintaining a hydrocarbonaceous matter in an alternating current electrical field generated by a radio frequency waveform at a frequency not greater than 300 mhz provided by a signal generating circuitry, said hydrocarbonaceous matter originating from said hydrocarbon-bearing formation and being contained in a subterranean reservoir; and

> controllably heating said hydrocarbonaceous matter by automatically maintaining an impedance match between said hydrocarbonaceous matter and a signal generating circuitry, said signal generating circuitry providing said radio frequency waveform.

28. A method for heating a hydrocarbon-bearing formation, comprising:

> maintaining at least one hydrocarbonaceous compound within a subterranean environment in an alternating current electrical field, said electrical field provided by a radio frequency waveform, said hydrocarbonaceous compound originating from said hydrocarbon-bearing formation;

> periodically sensing an impedance of said hydrocarbonaceous compound and undesired organic and inorganic compositions to produce a sensor output signal;

> determining impedance mismatch based on a difference between a most recently sensed impedance and a known impedance, and generating a corresponding control signal output that corresponds to said difference with a computer; and

> as said hydrocarbonaceous compound and undesired organic and inorganic

compositions increase in temperature, adjusting said frequency of said radio frequency waveform by said control signal output of said computer such that said impedance matches said most recently sensed impedance.

29. A method of separating a hydrocarbonaceous matter from undesired matter commonly associated with a hydrocarbonaceous formation, comprising:

maintaining hydrocarbonaceous matter and undesired matter in an alternating current electrical field provided by a radio frequency waveform, said hydrocarbonaceous formation being exposed to a subterranean reservoir, said reservoir comprising a fluid carrier medium, said fluid carrier medium allowing passage of said radio frequency waveforms to penetrate and heat said hydrocarbonaceous formation;

periodically sensing an impedance of said hydrocarbonaceous matter and said fluid carrier medium to produce a sensor output signal;

determining an impedance mismatch based on a difference between a most recently sensed impedance and a known impedance, and generating a corresponding control signal output that corresponds to said difference with a computer; and,

as said hydrocarbonaceous matter and said fluid carrier medium increase in temperature, adjusting said frequency of said radio frequency waveform by said control signal output of said computer such that said sensed impedance matches said most recently sensed impedance, such that said hydrocarbonaceous matter will rise in temperature and decrease in viscosity, and thus rise to the surface of said reservoir and dropping out said undesired matter to settle as sediment in said reservoir.

30. A method for heating a medium, said medium comprising hydrocarbonaceous material selected from the group consisting of oil shale, tar sand, oil sand, coal, bitumen, and/

or kerogen, comprising:

testing a first sample of said medium to determine a first impedance at several
different temperatures;

storing a resulting said first impedance vs. temperature information for said medium in
a memory of a computer;

flowing a signal through a second sample of said medium, said signal being presented
to said medium to be a radio frequency not greater than 300 MHz;

sensing the impedance of at least one portion of said second sample;

determining, by operation of said computer, a relationship between a most recently
sensed impedance of said medium and a heating rate of said medium; and

adjusting said heating rate of said medium based on said relationship.

31. The method of claim 30 wherein said medium is heated with said radio frequency
and released under a pressure.

32. A method for heating at least one chemical composition residing in a medium, said
medium comprising hydrocarbonaceous material selected from the group consisting of
oil shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, comprising:

maintaining said chemical composition in an alternating current electrical field
provided by a radio frequency signal at a frequency not greater than 300 MHz; and

controllably heating said chemical composition by automatically maintaining an
impedance match between an impedance of said chemical composition and a
predetermined constant, said predetermined constant comprising an optional fluid
carrier medium, which can be unaffected, when desired, by said frequency being
presented to said chemical composition.

33. The method of claim 32 wherein said medium is selected from the group
consisting of water, saline solution, and/or carbon dioxide.

34. The method of claim 32 wherein said medium is heated with said frequency
and released under a pressure.

35. A capacitive radio frequency dielectric heating apparatus for heating a medium, said
medium comprising hydrocarbonaceous material selected from the group consisting of
oil shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, the apparatus comprising:

maintaining a source of an alternating current radio frequency signal at a radio
frequency not greater than 300 MHz, said source being connected to a pair of
electrodes on opposite sides of a product treatment zone to cause an radio
frequency signal to generate an alternating current electric field in said medium
residing within said product treatment zone;

a frequency controller to adjust said frequency of said radio frequency signal between
different said radio frequencies;

a mathematical model that predicts impedance of said medium as a function of
temperature;

an impedance sensor to sense impedance data of said medium; and

a computer programmed to receive said impedance data from said impedance sensor,
to process said impedance data using said mathematical model for said medium,
and to apply a control signal to said frequency controller to adjust said frequency
of said radio frequency signal to match said sensed impedance to a predetermined
impedance.

36. The apparatus of claim 35 wherein the source of said alternating current radio
frequency signal includes a frequency generator connected to a power
amplifier.

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37. The apparatus of claim 36 further comprising an impedance matching network tunable to match the output impedance of said power amplifier to impedance of a load comprising said pair of electrodes and any said medium in said product treatment zone between said two electrodes.

38. The apparatus of claim 36 further comprising a directional coupler coupled to a transmission line leading from said power amplifier to receive signals proportional to levels of power supplied from said amplifier.

39. The apparatus of claim 38 wherein the directional coupler includes a forward power portion that receives signals proportional to the power supplied by the amplifier and a reverse power portion that receives signals proportional to power reflected back to the amplifier.

40. The apparatus of claim 39 comprising a measurement instrument connected to receive said respective signals from said forward and reverse power portions.

41. The apparatus of claim 40 wherein said measurement instrument computes a voltage standing wave ratio.

42. The apparatus of claim 41 wherein said measurement device computes a load reflection coefficient.

43. The apparatus of claim 40, wherein said computer is connected to and receives input signals from said measurement instrument, and said received input signals are processed with said temperature data in generating said control signals.

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44. The apparatus of claim 35 wherein the said treatment zone is within a
    pipe.

45. The treatment zone of claim 44 wherein said medium is a slurry.

46. A capacitive radio frequency dielectric heating apparatus for a medium, said medium
    comprising hydrocarbonaceous material selected from the group consisting of oil
    shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, the apparatus comprising:

    a source of an alternating current radio frequency signal at a frequency not greater than
        300 MHz;

    a first electrode that is connected to said source; a second electrode that is connected
        to said source and that is spaced from said first electrode so that a product
        treatment zone is defined between said electrodes and said radio frequency signal
        flows through said medium located within said product treatment zone; and

    impedance matching means for matching an impedance of said medium being heated
        to a predetermined constant by adjusting said frequency of said radio frequency
        signal.

47. The apparatus of claim 46 wherein each of said first and second electrodes
    have   multiple electrode elements which are electrically isolated from one
        another, individual elements of said first electrode being located opposite
        corresponding individual elements of said second electrode to provide
        multiple pairs of opposed electrode elements.

48. The apparatus of claim 46 wherein a computer-controlled switch is connected
    in said radio frequency signal supply circuit for each pair of electrodes so
        that individual electrode pairs can be turned off and on by said computer.

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49. The apparatus of claim 46 further comprising temperature sensors, and wherein at least some of the temperature sensors are supported on the first electrode.

50. The apparatus of claim 46 wherein the said treatment zone is within a pipe.

51. The treatment zone of claim 50 wherein said medium is a slurry.

52. A capacitive radio frequency dielectric heating apparatus for heating a medium, said medium comprising hydrocarbonaceous material selected from the group consisting of oil shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, the apparatus comprising:

at least one pair of spaced-apart electrodes defining a heat treatment zone for heating said medium;

signal generating circuitry connected to said electrodes, said signal generating circuitry being capable of providing an alternating current radio frequency signal to charge said electrodes and generate an alternating current electric field in said heat treatment zone;

impedance measuring circuitry connected to said electrodes and to said signal generating circuitry, said impedance measuring circuitry measuring an impedance of said electrodes and at least one chemical composition within said medium located in said treatment zone; and

a controller linked to said impedance measuring circuitry and said signal generating circuitry, said controller controlling said signal generating circuitry and said alternating current electric field generated thereby based on said impedance measured by said impedance measuring circuitry.

53. The apparatus of claim 52 wherein said signal generating circuitry includes a

variable frequency radio frequency signal generator.

54. The apparatus of claim 52 wherein said signal generating circuitry includes an amplifier connected to said variable frequency radio frequency signal generator.

55. The apparatus of claim 52 wherein the said treatment zone is within a

pipe.

56. The treatment zone of claim 55 wherein said medium is a slurry.

57. A capacitive radio frequency dielectric heating apparatus for heating a medium, said medium comprising hydrocarbonaceous material selected from the group consisting of oil shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, the apparatus comprising:

a source of an alternating current radio frequency signal at a radio frequency not greater than 300 MHz, said source being connected to a pair of electrodes on opposite sides of a product treatment zone to cause said radio frequency signal to flow through said product treatment zone;

a frequency controller to adjust said radio frequency of said radio frequency signal between different radio frequency frequencies;

a mathematical model that predicts Debye resonance frequency as a function of temperature for said medium to be heated by said apparatus;

a temperature sensor to measure temperature data of a said medium located in said zone; and

a computer programmed to receive said temperature data from said temperature sensor, to process said temperature data using said mathematical model for said medium, and to apply a control signal to said frequency controller to adjust said frequency of said radio frequency signal to a Debye resonance frequency of said

product at said sensed temperature in said zone.

58. The apparatus of claim 57 wherein said mathematical model provides Debye resonance frequency information for at least one chemical composition within said medium; and said apparatus further comprises an input device that communicates to said computer what type of said medium is located in said zone.

59. The apparatus of claim 57 wherein said input device communicates to said computer what type of said medium is located in said zone.

60. The apparatus of claim 57 wherein said mathematical model is a data table that contains Debye resonance frequencies for at least one chemical composition within said medium at various temperatures.

61. The apparatus of claim 57 wherein said mathematical model predicts the Debye resonance frequencies for at least one chemical composition residing in said medium based on dielectric properties of said chemical composition.

62. The apparatus of claim 57 further comprising a field strength controller that responds to signals from the computer to adjust the power level of the radio frequency signal in the zone.

63. The apparatus of claim 57 wherein said mathematical model provides Debye resonance frequency information for at least one chemical composition residing in said medium;

said apparatus further comprises an input device that communicates to said computer whether said medium is in contact with a chemical composition that can function as a carrier medium of said frequency to at least one said chemical composition targeted for heating, and

said computer being programmed to signal said frequency controller to adjust

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said frequency of said radio frequency signal to a frequency that is not a
Debye resonance frequency of said carrier medium

64. The apparatus of claim 57 wherein the said treatment zone is within a
pipe.

65. The treatment zone of claim 64 wherein said medium is a slurry.

66. A capacitive radio frequency dielectric heating apparatus for heating a medium, said
medium comprising hydrocarbonaceous material selected from the group consisting of
oil shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, the apparatus comprising:

a source of an alternating current radio frequency signal at a frequency not greater than
300 MHz;

a first electrode that is connected to said source; a second electrode that is connected
to said source and is spaced from said first electrode so that a treatment zone is
defined between said first and second electrodes and a radio frequency signal flows
through said medium in said treatment zone;

multiple temperature sensors positioned to measure temperature data at multiple
regions of said medium located in said zone; and

a computer which receives temperature data from said temperature sensors, processes
said temperature data using a mathematical model for said medium, and adjusts at
least one characteristic of said radio frequency signal in response to changes in
said sensed temperatures in said zone.

67. The apparatus of claim 66 wherein each of said first and second electrodes
have multiple electrode elements which are electrically isolated from one
another, individual elements of said first electrode being located opposite

corresponding individual elements of said second electrode to provide
multiple pairs of opposed electrode elements.

68. The apparatus of claim 66 wherein a computer-controlled switch is connected
to said radio frequency signal supply circuit for each pair of said electrodes so
that individual said electrode pairs can be turned off and on by said computer.

69. The apparatus of claim 66 wherein at least some of said temperature sensors
are supported on said first electrode.

70. The apparatus of claim 66 wherein the said treatment zone is within a
pipe.

71. The treatment zone of claim 70 wherein said medium is a slurry.